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BER Performance of Convolution Coded Cooperative Relay Network in κ-μ and η-μ Fading Environment

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***Abstract*: In this paper the BER performance of the convolutional coded Amplify-and-forward (AF) cooperative relay network is evaluated over κ-μ and η-μ fading channel. Source node of the considered system transmit ½ rate convolutional coded data which are modulated using Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK) modulation techniques to the sink node. System incorporates multiple relays along with the direct link for relaying the modulated data from source node to sink node. The paper represents the simulation results to visualize the effect of number of relay between the source and sink node, modulation techniques and channel model parameters on the system performance.**

***Index Terms*: Amplify-and-forward, convolutional codes, κ-μ and η-μ fading, BPSK, QPSK**

I. INTRODUCTION

The need of the hour is to upgrade the capabilities of existing cellular networks. Although the various proposed techniques enhance the spectral efficiency but they also increase the installation cost of the Base Station (BS) by huge amount [1]. Cooperative relaying is an admissible technique to enhance the spectral efficiency and reliability of the system at low cost. It creates virtual MIMO system by creating the cooperation between various single antenna systems to combat the effect of fading [2].Depending upon the processing method adopted at the relay node mainly three types of relaying protocol proposed in literature which is: Amplify-and-forward (AF), Decode-and-forward (DF) and Compress-and-forward [3]. In the first one, the corrupted signal received at the relay node is amplified and retransmitted to the sink node. In DF protocol relaying node performs decoding and encoding on the received signal before transmitting it to the sink node. In CF protocol relay performs quantization operation on the signals received from the source node then forward compressed version of these signals to the sink. AF is the simplest protocol among these three, as in case of AF protocol relay node does not perform decoding or compression operation [4] [5].

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In this paper BER performance of the convolutional coded Amplify-and-forward (AF) cooperative relay network is evaluated over κ-μ and η-μ fading channel. System incorporates multiple relays along with the direct link for relaying the modulated data from source node to sink node. There are two phases of transmission. In the first phase, the source node transmits ½ rate convolutional encoded data which are modulated using BPSK and QPSK modulation techniques to the N relays and sink node as shown by the dotted lines in the figure 1. In second phase, the relay node transmits amplified version of the received signals to the sink node as shown by the solid lines in the figure 1. All links of the system i.e. S→R, S→D and R→D undergo κ -μ and η -μ fading channel.

II. RELATED WORK

Performance of any relay network depends on various parameters such as: Data rate, Diversity, Fading channel parameters and Network Size. In [6] authors have presented the effect of such parameters and found that the system performance degrades as the size of the network increases. Literature shows that network coding can also improves system performance by significant amount. In [7] authors perform simulation of the system which employs cooperative network coding at the source end and MRC, SC diversity techniques at the sink end. Performance of a cooperative DF network over κ-μ, η-μ, and mixed fading environment is analyzed in [2] and concludes thatthe performance delta was higher when increase occurs in the R →D link parameters rather than the S→R link parameters. In [8] [9] authors analyzed how an AF cooperative relaying network fares over different fading channels such as; Weibull, Exponentiated Weibull, asymmetric channel.

III. SYSTEM MODEL

We consider cooperative relay network which comprises N-relays, a source node and a sink node. AF relaying protocol is being employed at relay nodes which operates in half duplex mode and has a single antenna. Considered system creates cooperation in two phases. In first phase source node transmit ½ rate convolutional encoded data which are modulated using BPSK and QPSK modulation techniques,to the N relay nodes and sink node simultaneously.Mathematically signal acquired at the j^{th} relay and sink node may be expressed as

$$y_{SR_j} = \sqrt{P_t} X h_{SR_j} + n_{SR_j} \quad \ldots.(1)$$

$$y_{SD} = \sqrt{P_t} X h_{SD} + n_{SD} \quad \ldots.(2)$$

Where P_t represents the transmitted power from the source node and X represents modulated data. Channel coefficients from source node to j^{th}relay node and target node is represented by h_{SR_j} and h_{SD} respectively. n_{SR_j} and n_{SD} represents the AWGN noise at j^{th}relay node and sink node respectively. In the second phase of transmission relay nodes amplify the signal received from the source node with amplification factor β and transmit it to sink node. Mathematically gain experience by the j^{th} node and signal reaches at the sink node from j^{th} relay node can be represented as

$$\beta_j = \frac{\sqrt{P_j}}{\sqrt{P_t |hsr_j|^2 + N_0(j)}} \quad \ldots.(3)$$

$$y_{RD_J} = \sqrt{P_t} y_{SR_j} h_{RD_J} \beta + n_{RD_j} \quad \ldots.(4)$$

Sink node applies MRC scheme to combine and Viterbi algorithm to decode the signals acquired from the direct link and the indirect link.

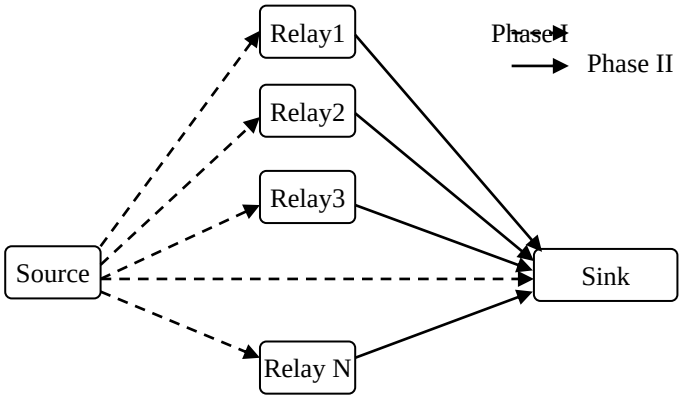

Fig. 1 System Model

IV. SIMULATION RESULT

In this section simulation results are presented to visualize the effect of number of relay between the sources and sink node, modulation techniques and channel model parameter variations on the performance of cooperative relay network. MATLAB simulation has been carried out with different parameters as mentioned in table 1.

Table1 Simulation parameters

Parameters	Value
Number of input data	100000
FEC coding	Convolutional codes
Code rate	½
Modulation techniques	BPSK,QPSK
Channel model	κ-μ, η-μ
Number of antenna at each node	Single
Number of relay nodes	1,2,4
Relaying Protocol	Amplify-and -forward
Combining technique	MRC
SNR values	0:20
Decoding algorithm	Viterbi

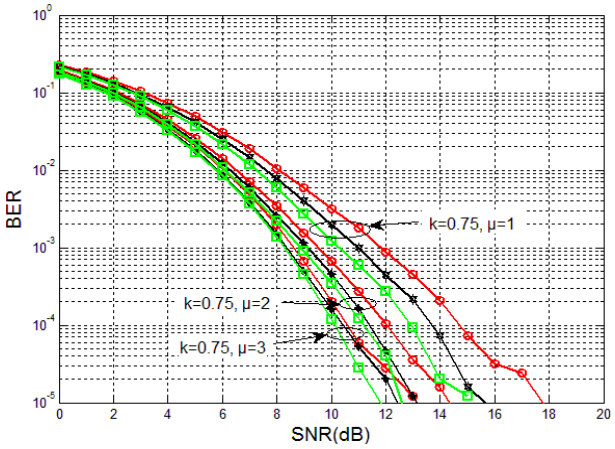

Fig. 2 BER performance of the system employing BPSK modulation over κ-μ fading channel for different values of μ and κ=0.75

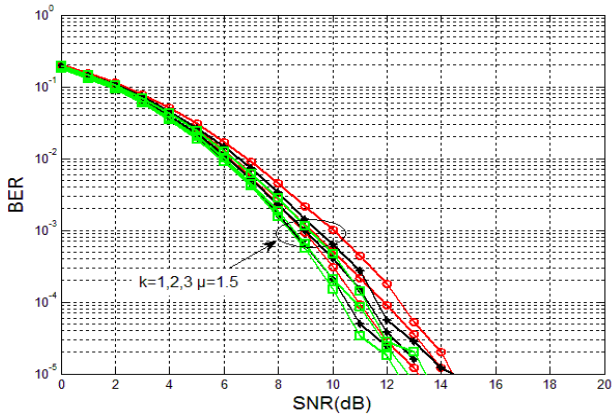

Fig. 3 BER performance of the system employing Binary PSK modulation over κ-μ fading channel when μ =1.5 and κ takes different values

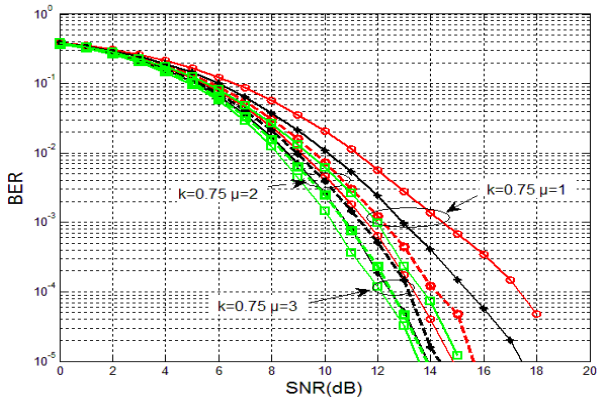

Fig. 4 BER performance of the system employing QPSK modulation over κ-μ fading channel for κ=0.75 and μ takes different values.

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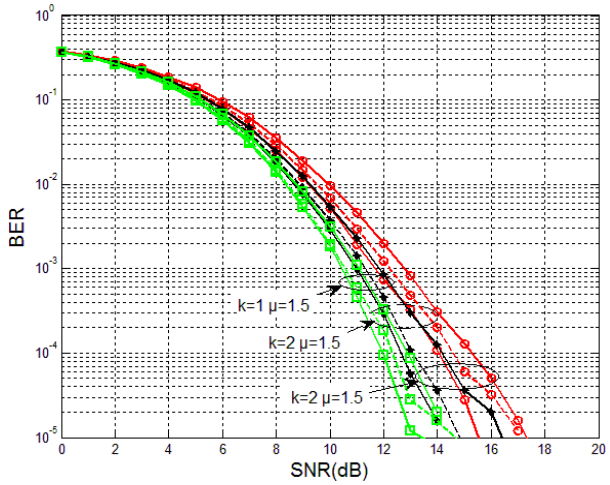

Fig. 5 BER performance of the system employing QPSK modulation over κ-μ fading channel when μ =1.5 and κ takes different values

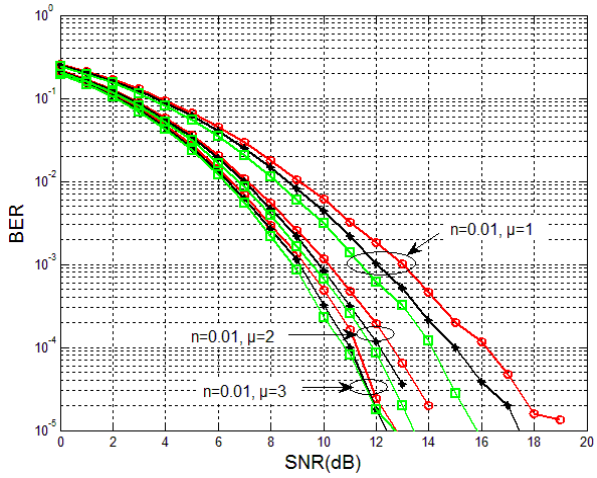

Fig. 6 BER performance of the system employing Binary PSK over η-μ fading channel when η=0.01 and μ takes different values.

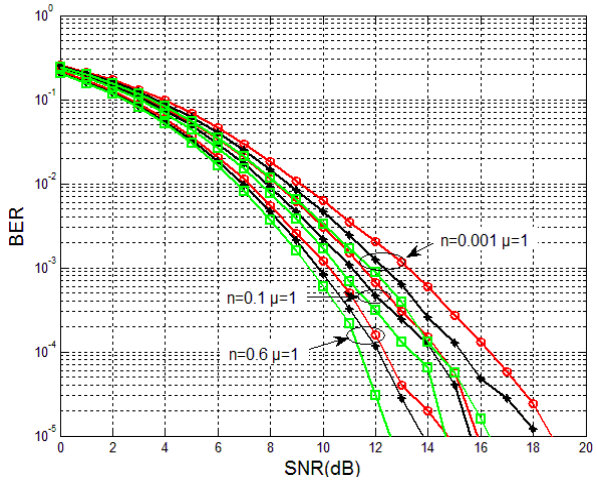

Fig. 7 BER performance of the system employing BPSK modulation over η-μ fading channel when μ=0.01 and η takes different values

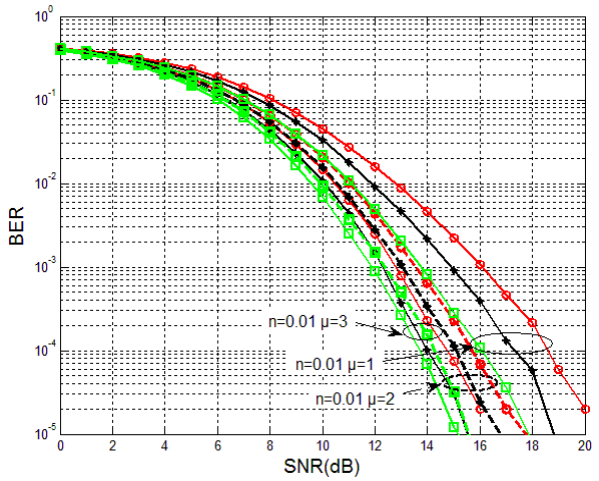

Fig. 8 BER performance of the system employing QPSK modulation over η-μ fading channel when η=0.01 and μ takes different values

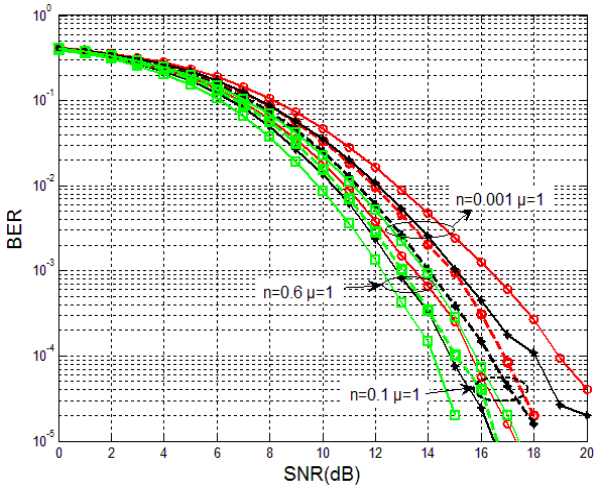

Fig. 9 BER performance of the system employing QPSK modulation in an η-μ fading channel when μ=0.01 and η takes different values

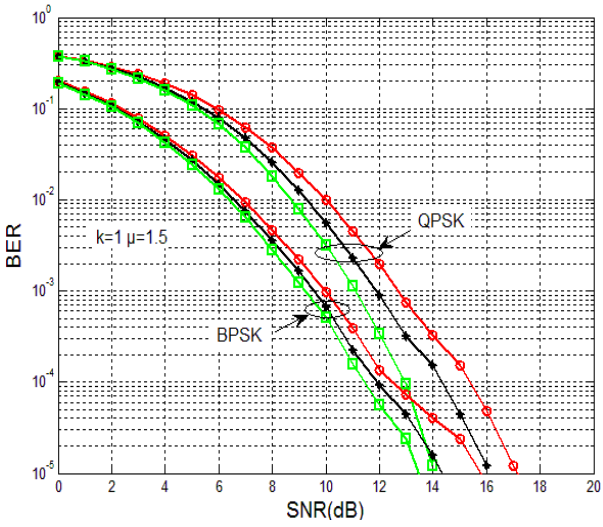

Fig. 10 BPSK Vs QPSK Performance comparison of the system over κ-μ fading channel when μ=1.5 and κ=1

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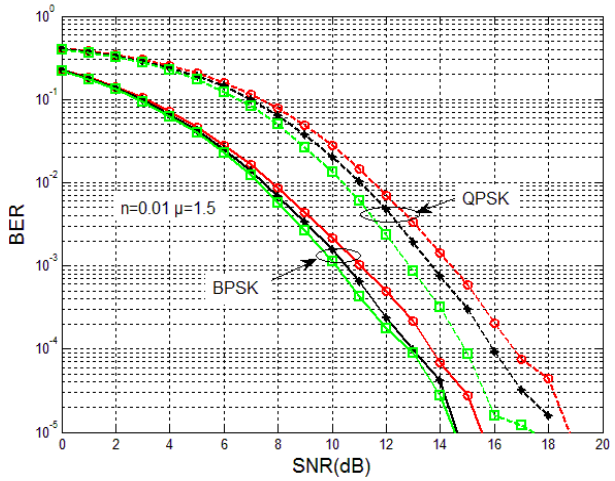

Fig. 11 BPSK Vs QPSK Performance comparison in an η-μ fading channel when μ=1.5 and η=0.01

V. CONCLUSION

Simulation results were shown in Section 3. It may be inferred that the performance of a convolutional coded AF cooperative relay network actively varies with different parameters such as: number of relay nodes, change in parameter values of fading channel and modulation technique. Simulation results show that system performance takes a turn for the good as the relay nodes increase. System simulations over two different fading channel models namely κ-μ and η-μ were conducted. By making the comparative analysis of the simulation results we noticed that rise in the value of μ in both channel models dominates the rise in other parameters i.e. κ and η. We also observe that BPSK modulation technique improves the system performance by more than 1 dB as compare to the QPSK.

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